

CODMAN (E.A.)

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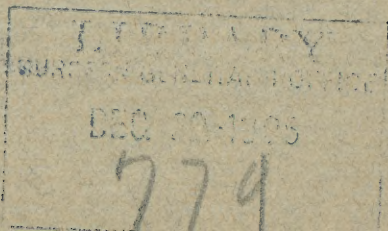
BY

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A STUDY OF THE CASES OF ACCIDENTAL X-RAY BURNS HITHERTO RECORDED.

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vard Medical School.

In the *Medical Record* for 1900, No. LVII, p. 180, Dr. Patrick Cassidy has given an excellent account of the unfortunate case of Dr. Weldon, of Willimantic, Conn. On March 18, 1899, Dr. Weldon exposed himself for an X-Ray picture of the hip-joint for forty-five minutes, with the Crookes tube but five inches from the skin of his groin. A most intractable burn resulted, necessitating a severe operation, and producing disability for a year and a half. Since he alleged that the makers of his X-Ray apparatus, Otis Clapp and Son, of Boston, had warranted that the apparatus would not burn, he entered suit for \$20,000.00 damages, and in the United States District Court, November 8, 1901, was awarded \$6,750.00. The writer, with other X-ray experts* was called to testify by the defence. It is not intended to discuss here the evidence offered in this case, but rather to endeavor to answer the questions suggested by it. The facts on which these answers can be based must come from one of two sources—from the literature of the subject or from the writer's personal experience. The personal experience of a single man, in cases which are as rare as the lesions in question, is inconsiderable as compared with the recorded experience of the profes-

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sion in general. For instance the writer** might be expected to have some personal knowledge of the cases occurring in the large hospitals in his city, where the X-Ray is daily used, or of cases occurring in the practices of colleagues, or of cases coming to hospitals from the outlying towns in his neighborhood, but for the larger part of his information he must have the authority of record. The writer therefore found it necessary to search the literature for other cases to compare with his own, and his desire is to record the results of his search in the hope that they may be of service to others. Beside the medico-legal interest of this investigation he assumes that general practitioners may desire to know what the danger is of a patient receiving a burn when they send him for an X-Ray, and that those who are entering on the therapeutic use of this agent will be glad to hear of the unfortunate experiences of others in order to determine the proper distances and times for exposure.

****X-Ray Injuries in Boston.**

No case of accidental injury to a patient has occurred in Boston to my knowledge with one possible exception. I was told by another physician of a case of dermatitis of the foot in a lady who had an X-Ray at the Massachusetts General Hospital. I am unable to get the details of this case, but was impressed at the time that the diagnosis was not clear. I have also heard of a case of a mild erythema on the back of a girl who was examined with a fluoroscope in Jamaica Plains. These cases are not included in my series.

The first six of the following cases have come to Boston from other cities or towns:

Daisy M. Orleman, No. 97, treated by Dr. H. L. Burrell. Burn occurred in New York.

George D., No. 22, treated by Dr. Burrell. Burn occurred in New York.

M. L. H., No. 156, reported by Dr. White. Burn occurred at Oberlin College.

E. E., No. 66, probably reported by Prof. Hoffa. Burn occurred in Germany.

Henry Allard, No. 35, at Massachusetts General Hospital for one day. Burn occurred in Lawrence, Mass.

Dr. Weldon, No. 33, scar seen in court by writer. Burn occurred in Willimantic, Conn.

W. J. D., No. 36, Skiagrapher's dermatitis, very severe. Burn occurred at Massachusetts General Hospital.

Another case of burn on knee. Hearsay evidence that such a case came to O. P. D. of Massachusetts General Hospital. Did not occur in Boston. This case is not included.

Eight other cases, Nos. 161 to 169, of dermatitis of the hands (five in doctors, two in makers of apparatus, one in an apothecary), have been seen by writer.

The Literature.

Gilchrist and N. S. Scott, in America, Barthelemy, Oudin and Darier, in France, and Kienböck, in Germany have already made collections of X-Ray injuries, and the writer has been greatly aided by their articles. The reduplication of reported cases is especially evident in this subject, and the publicity which was given to many of the early cases is striking. The profession may be congratulated upon the promptness with which the warning was spread. The cases of Apostoli, Crocker, Drury, Freund, Gilchrist, King, Marceuse, Thompson and many others have been published over and over again. When these published cases are reduced to their lowest terms, they turn out to be comparatively few, even including many which are merely spoken of in reports of medical meetings. Most of these latter are given even if they have practically no data. A few cases voluntarily produced for experimental purposes are excluded, as are those in which the burning has been intentionally used for therapeutic purposes, since in these the skin is presumably already in an abnormal condition. A few cases occurring when the X-Ray has been used as a depilatory with no intention of burning have been included. The bibliography of Guichard (*Tribune Medicale*, March 3, 1899) has not been at the disposal of the writer, nor has the article by Albers-Schönberg, (*Fortschritte a. d. Gebiete der Röntgen-Strahlen*, '98, Bd. 1, Heft 2). Both of these, however, antedate Kienböck. In most of the other cases the writer has read the original reports and has taken great pains to get every possible reference which the unusual collection of periodicals in the Boston Medical Library furnishes. It was a matter of great surprise to find the number of recorded cases so small, and that each was so often copied in other journals.

Value of the Reported Cases.

The question of whether the reports which are here analyzed are accurate and truthful may natur-

ally be raised. It may be said that the operator to shield himself from the law, or to recover damages, may falsely represent the data. The writer wishes to point out that most of these cases are records of early mistakes in which the patient took the risk as well as the skiagrapher; many are reported by others than the skiagrapher or the patient and many were in the persons of the operators themselves. It may also be said that men would endeavor not to let such mistakes come into public notice on account of the damage to their reputation. This is undoubtedly so to a certain extent, but it is also true that bad news travels faster than good news, and other men or the patients themselves would make them public. This is particularly so with the bad injuries. It is therefore the writer's opinion that most of the bad injuries, at least, are included in these tables, and that the value of the statistics is considerable. Many cases of skiagraphers' dermatitis have probably not been recorded.

Relative Number of Cases.

The total number of cases herewith presented is less than 200. The question naturally occurs how many cases of X-Ray exposures does this figure represent? The author knows of over 20,000 exposures in the hospitals of Boston, a city of approximately 500,000 inhabitants. The sum of the populations of the ten principal cities in England, France, Germany, Austria and the United States in 1891 was about 25,500,000. Since X-Ray injuries occurring in these cities would probably be recorded in the journals examined, it is fair to consider that these statistics would be drawn from over 1,000,000 exposures. This means that even at a minimum of the probable number of exposures and including the early experimental work, only one case in 5,000 has been injured, and less than a half of these seriously. This figure falls in with the experience in the Boston Hospitals where in 20,000 cases there have been no burns in patients, and but four cases of dermatitis in skiagraphers, one being serious. This is also

equivalent to one case in 5,000. These figures are arrived at by taking a minimum on the side of exposures (i. e. there have probably been many more than 20,000 cases taken in Boston; only 10 cities in each country are included and the population of these cities is in the figures of 1891), and a maximum on the side of reported cases of injury. If to make assurance doubly sure we admit that five times as many burns have occurred as have been reported, we find that only one case in a thousand has been injured. Again if we exclude past years and take only the cases occurring in the current year, we find only one or two in 200,000. We may safely tell a patient to-day that there is not one chance in 10,000 of his receiving injury from an ordinary X-Ray exposure. Obviously, this makes the case against a physician charged with causing such an injury very hard.

Chronology of the Reported Cases.

The dates of certain cases are not given at all. Of others only the dates on which they were reported. The first cases reported were those of Daniel, in America, April 10, 1896; Leppin, in Germany, July 9, 1896; Stevens, in England, April 18, 1896.

55	cases	occurred	in	'96.
12	"	"	"	'97.
6	"	"	"	'98.
9	"	"	"	'99.
3	"	"	"	'00.
1	"	"	"	'01.

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Of the remaining cases whose dates are not given

27	cases	were	reported	in	'97.
4	"	"	"	"	'98.
6	"	"	"	"	'99.
23	"	"	"	"	'00.
1	"	"	"	"	'01.

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The reason that 23 cases are reported in 1900 is that the collections of Butler and Barthelemy ap-

peared in that year and in many instances the authors have neglected to give dates. The injuries presumably occurred in '96 or '97.

The main reasons for such a decrease have been the bitter teachings of experience and the fact that the introduction of better apparatus has done away with long exposures and the close approximation of the tube.

Cause of X-Ray Injuries.

The cause of X-Ray injuries is not known. It could not, of course, be determined by such a study as this. Since the author, in the course of his reading, has unavoidably reviewed the explanations of different writers on this subject, the reader may demand an expression of opinion. Most writers agree that the active cause is not heat, nor the brush discharge, nor the photographically active X-Ray itself, but some form of energy radiating from the platinum terminal together with the X-Ray, and probably closely related to it, on the one hand, and to ultra-violet light, on the other.

Classification of X-Ray Injuries.

The injurious effects of the X-Ray fall naturally in five classes. The first (a) I will call skiagrapher's dermatitis. It occurs chiefly on the hands or faces of X-Ray workers—in those who are frequently exposed to the action of the rays, in tube-makers, experimenters, exhibitors and professional skiagraphers. It results from repeated short exposures, usually in the use of the fluoroscope or from demonstration of the bones of the hands to an audience. It is most often of a mild degree, but with continued exposure may go on to ulceration and gangrene of the skin, even to involvement of the tendon sheaths and joints. In the less pronounced forms the skin appears chapped and roughened and the normal markings are destroyed; at the knuckles the folds of skin are swollen and stiff, while between there is a peculiar dotting resembling small capillary hemorrhages. The nutrition of the nails is affected

so that the longitudinal striations become marked and the substance becomes brittle. If the process is more severe there is a formation of blebs, exfoliation of epidermis and loss of the nails. In the worst form the skin is entirely destroyed in places, the nails do not reappear and the tendons and joints are damaged.

The next three classes of cases occur accidentally in patients who are exposed one or several times at short intervals for skiagraphs. They vary in intensity and may be directly compared with burns of the 1st, 2nd and 3rd degree. They are essentially the same as the forms occurring in skiagraphers spoken of above.

(b) The mild cases are simply a transient erythema lasting perhaps a few days, followed by an exfoliation of superficial epidermis. There may be hyperesthesia of the skin and a slight burning sensation, but no real pain. In the hairy portions depilation may occur without inflammatory signs.

(c) In cases of the 2nd degree there is a formation of blisters following the erythema; these may be serous or purulent; the condition resembles a scald, but is slower in healing and less acute in character.

(d) In the worst cases the process, instead of disappearing in a few weeks, seems to extend to the deeper layers of the skin and subcutaneous tissues. There is a formation of a leathery slough, surrounded by a brawny indurated swelling with ill-defined limits. The process is exceedingly slow and obstinate and possesses an almost malignant tendency to progress. It is very painful at times and resists treatment in a remarkable way. The reader is referred to the case of Dr. Weldon and to the report of Orleman which are typical cases of this kind.

(e) The fifth group of cases is composed of those in which some internal lesion is attributed to the X-Ray. There have been few such cases recorded and these have been in such an inexact and hypothetical way with the exception of that of Gilchrist,

that they seem to the writer to be undeserving of record. Dr. N. Stone Scott, in his excellent discussion of this subject, finds no adequate evidence of the existence of such lesions; and the writer fully agrees with him. In the author's opinion Dr. Scott's explanation of the case reported by Gilchrist is amply sufficient.

Pathology.

The writer coincides with the balance of opinion which attributes these lesions to a primary action on the trophic nerves of the blood vessels and skin. The delay in the appearance of the lesions after the exposure, their progressive character, and their failure to react to stimulating treatment are the strongest reasons for this view. The reports of microscopical examination of the excised tissue agree in stating that the smaller arterial branches are occluded, and the appearances are not unlike those of necrosis and inflammation due to other causes. The severe lesions are rather atrophic ulcers than burns.

Numerical Classification.

In cases in which the kind of lesion is recorded;	
53 were skiagrapher's dermatitis.	(a)
14 were of the 1st degree.	(b)
29 were of the 2nd degree.	(c)
71 were of the 3rd degree.	(d)

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Factors Contributing to the Production of X-Ray Injuries.

Apparatus.

Many assertions have been made that the static machine is less liable to cause serious injury than other forms of apparatus, because of the low amperage of its output. This statement is not entirely borne out by the present analysis. In the cases in which the kind of apparatus is recorded.

11 were caused by static machines, of these 3 were severe.

11 were caused by Tesla coils, of these 5 were severe.

42 were caused by forms of induction coils, of these 18 were severe.

On the other hand, coils have been far more commonly used than static machines or the Tesla apparatus, probably more than three times as much. In the other cases in which the apparatus is not spoken of, it is improbable that a static machine would have been used and not mentioned. The writer believes that it is a general impression among experts that the static machine is less dangerous and it is therefore less recommended for therapeutic purposes. However, it certainly is not free from danger.

Spark Length.

The voltage as measured by the spark length of the apparatus used is another factor of importance. Its actual share in the production of these injuries is very difficult to determine, for in the early days of the X-Ray work long exposures with very weak apparatus were used. The relation of this factor to time and distance will be discussed later, but in general it may be said *a priori* that, other conditions remaining the same, the greater the spark length the greater the probability of danger. But 16 of my series have the spark length with other data recorded. It varies from 4 to 12 inches.

Primary Current.

In many cases the quality of the primary current is recorded; but since the tube is actuated by the secondary current, the intensity of which depends largely on the winding of the coil and the efficiency of the interrupter, these figures have little value. However, *a priori* the greater the amperage of the secondary current, the greater would be the chance of danger, provided the voltage was also considerable.

Quality of the Tube.

Unfortunately the quality of the tube is not recorded often enough to give us effective data. Where it is recorded it is usually stated to be "soft". It is the general impression of skiagraphers that soft tubes have more therapeutic influence than hard. Kienböck devotes much attention to this point. It is probable that the distance from the skin and time of exposure are more important factors.

Distance and Time.

Maximum recorded distance from tube to skin at which injury has occurred, 50 cm. (statement of patient).

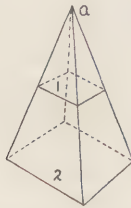
Minimum recorded distance from tube to skin, 1 cm.

Maximum recorded time of exposure to skin, 20 hours. (in 10 exposures).

Minimum reported time of exposure, 5 min. (other data not given).

Considerable inaccuracy probably exists in the accompanying reports of times and distances. One writer speaks of "distance from tube to skin." Another "from tube to plate"; another from "platinum terminal to skin"; still others say the tube was "x inches distant" or perhaps neglect the entire data. The writer has therefore endeavored not to be too particular and has accepted the distance given without asking questions. The platinum terminal was seldom more than an inch from the glass in the days when most of these cases occurred. This inch or more has been disregarded and the figure given accepted as being distances from the terminal to the skin. This, of course would make a considerable difference in the exposures at short distances. It might perhaps have been more accurate to add an inch to each given distance, but since the distance was probably more often guessed than measured the two factors may balance, for guesses are usually greater than measurements.

From a consideration of these figures it is evident that we need some standard of comparison which will represent the total exposure in a given case, expressing both time and distance. In general we may say that the danger like the intensity of the X-Rays varies directly as the time, and inversely as the square of the distance. This is the simple law for light or any other energy radiating from a point. It may be geometrically thus.



If a is the focal point, and 2 is twice the distance of 1 , then 2 will be four times as large as 1 , and the intensity of radiant energy reaching it will be one fourth as great per square inch.

Using this law and assuming that other conditions remain the same, we may express all the recorded exposures in terms of minutes at one inch, i. e.:

If T = Time in minutes and

D = Distance from skin to tube

then $T \div D^2$ = equivalent exposure in minutes at 1 inch distance.

For purposes of comparison I have arranged the definitely recorded cases in the following table. It is assumed that repeated exposures at short intervals are equivalent to added exposures. Only cases in which a fair amount of detail has been given are included.

TABLE I.

No.	Inches from tube.	Exposure in minutes.	Days of incubation.	Severity.	Comparative time at 1 inch.
102	19.68	30	1	severe	.08
72	15.00	30	14	mild	.13
66	11.81	25		severe	.18
113	10.00	20	7	medium	.20
97	10.00	21	21	severe	.21
112	8.00	15	3 hours	medium	.23
124	6.00	20	2 hours	medium	.55
16	10.00	60	6	severe	.60
87	3-4	10	14	severe	1.11 or .63
38	8.00	45		severe	.70
96	3.94	17	8	medium	1.11
75	7.88	78		severe	1.27
19	(patient 6 in.) (oper. 15.32)				1.43 or 8.88
49	5.46	45	14	severe	1.50
45	5.85	52		severe	1.51
57	6.24	60	during	medium	1.54
62	6.00	60	14	severe	1.66
33	5.00	45	7	severe	1.80
156	6.00	75	2	severe	2.08
39	5.00	60	1	severe	2.40
52	4.29	45	2	severe	2.44
85	11.00	300		severe	2.48
63	8.00	180	10	medium	2.81
53	3.94	50	5	mild	3.28
41	3.00	30	28	medium	3.33
127	2.00 or 1.00	15	10	medium	3.75 15.00
139	4.00	60	10	severe	3.75
132	2-8 in.	300	at once	severe	75.00 or 4.69
148	1.5 cm.	25	1	severe	162.50 or 5.32
125	6.00	270	21	severe	7.50
126	6.00	270	28	severe	7.50
54	3.94	120	3	mild	7.89
1	15 cm. for	40	2	severe	8.51
	9 cm. for	90			
143	3.00	1.50	1.20 2	severe	16.66 11.11
71	3.94	2.10		severe	13.80
149	1.25	30	9	severe	19.20
59	1.96	80		severe	21.05
105	3.00	200	during	medium	22.22
15	1 (?)	30	5	severe	30.00
153	0.625	12	11	medium	30.23
47	2.00	150	2	severe	37.50
55	3.94	1200		mild	78.90
141	0.39	20	6	severe	129.00
40	0.50	60	21	mild	240.00

Note.—The writer is fully aware that these figures are far from accurate, owing to the lack of proper data in distance from the platinum or the glass wall. For instance, in

the last two numbers, if we allow an inch for the radius of the tube, we find that the time in minutes at one inch would read 10.53 and 26.60 instead of 129 and 240. In the cases in which the distance is considerable the change would not be so great. The figures are poor at best and serve more to suggest a method of comparison for the future, than as absolute figures for the past.

The minimum recorded exposure which has produced injury is then (case 102) equivalent to an exposure of only .08 of a minute or 5 seconds at one inch. Since this figure may be assumed to represent the extreme grade of idiosyncrasy on the part of any patient hitherto examined—one case in a million, we may consider that an exposure less than that is perfectly safe for use, e. g., .05 of a minute at one inch. Using this as a starting point and the same formula we arrive at the following times which may be considered perfectly safe for the given distances. We may say that no injury is recorded with

an exposure equivalent to or less than				.05 minutes at a distance of	1 in.
"	"	"	"	.02	2 "
"	"	"	"	.45	3 "
"	"	"	"	.80	4 "
"	"	"	"	1.25	5 "
"	"	"	"	1.80	6 "
"	"	"	"	2.45	7 "
"	"	"	"	3.20	8 "
"	"	"	"	4.05	9 "
"	"	"	"	5.00	10 "
"	"	"	"	7.20	12 "
"	"	"	"	16.20	18 "
"	"	"	"	28.80	24 "

As a matter of fact, and fortunately for the human race, these exposures are amply sufficient for good skiagraphs and are about the same as the average exposures in common use. It is also true that with most forms of apparatus we could not get on with much shorter ones. To be sure, if the tube was high or the spark length small, we might safely use longer ones. The reader must bear in mind that these are minimum figures and might be doubled or tripled in time, without any practical risk. When changing the distance, however, more discretion must be used.

The following is a table showing the relations of spark length to exposures, etc., as far as recorded. This seems to show that there is no constant rela-

tion between the voltage and the severity of the lesion, even when the time and distance are relatively equal.

TABLE II.

NO.	Equivalent in minutes at 1 inch.		Spark length.	Distance.	Time.	Severity.
40	240.00		6 in.	0.5 in.	60 min.	mild
141	129.00		3.9 "	0.39 "	20 "	severe
55	78.90		9.8 "	3.9 "	1200 "	mild
153	30.23		4 "	.63 "	12 "	medium
105	22.22		10 "	3 "	200 "	medium
149	19.22		4 "	1.25 "	30 "	severe
121*	6.66		12 "	3 "	60 "	medium
132	4.69	75.00	6-8 "	2-8 "	300 "	severe
127	3.75	15.00	6-8 "	1-2 "	15 "	medium
139	3.75		9 "	4 "	60 "	severe
63	2.81		6 "	8 "	180 "	medium
136*	1.50		2.35 "	5.5 "	45 "	severe
96	1.11		5.9 "	3.9 "	17 "	medium
87	1.11	.63	11-13 "	3-4 "	10 "	severe
124	.55		8 "	6 "	20 "	medium
97	.21		8 "	10 "	21 "	severe

Idiosyncrasy.

The factors which we have so far considered as tending to produce or favor injury have been:

Apparatus.

Spark length and voltage.

Primary current.

Quality of the tube.

Distance and time of exposure.

These are the factors which we have under our control; they are mechanical, inanimate and capable of being altered to suit our will, and if the cause of injury lies in their relative adjustment we may hope to avoid accident by proper technique. In fact we have learned by practical experience to keep at a safe limit. But in the future we ask more than to know what exposures are *safe*. To have the apparatus under control for therapeutic purposes we need to know the technique of *unsafe* exposures as well. To gain this knowledge we must take other factors into consideration. The recorded cases show a minimum limit for safe exposure, but they also

show a tremendous variation in the reaction of individuals to apparently the same conditions. Most of the exposures which are mentioned in the accompanying tables have probably been endured by other individuals with no harmful results. Conditions which produce a severe lesion in one case, cause only a slight reaction in others. Most X-Ray workers will confess that in their early cases they used much longer and closer exposures than many of those mentioned in these tables. We find Freund reporting a mild dermatitis with an exposure which amounted to 240 minutes at one inch, while Plonski reports a severe case at 20 inches with only a half hour exposure. To be sure, in Plonski's case the statement is made by the patient, but its likelihood is increased when we read the carefully written statements of Orleman, Cassidy and Borden. To account for this discrepancy we must suppose that the important element of difference lies in the apparatus and its adjustment or in the idiosyncrasies of the patient. Kienböck and others consider that the important factor is the degree of vacuum in the tube—its softness or hardness. The writer is still strongly of the opinion that this element of variation lies in the susceptibility of the patient, in the dryness or dampness of his skin; in his electrical resistance; in his anemia or plethora; in the acidity or alkalinity of his sweat; in his vasomotor irritability or in some other of the multiplicity of conditions which make a living organism different from a glass tube stimulated by a current of electricity. If Kienböck is right in dismissing this subject with "Eine nennenswerthe Indiosyncrasie, durch welche eine für den normalen Menschen wirkungslose Bestrahlung ein Geschwür aquiriren würde, ist bisher nicht bekannt geworden und dürfte auch kaum existiren", Röntgen therapy may soon be free from danger—at present it is not.

We must confess that our known limits of danger are wide, and, by individual experiment and a careful record of the technique of therapeutic cases, we

must narrow these limits until they become those of the individual. It would be well to adopt a standard of intensity of exposure which, so far as the inches and minutes are concerned, should represent the unit of dose, as it were. The other factors e. g., the quality of the tube, could then (as nearly as possible) be arranged to agree; this would leave the idiosyncrasy more directly to be measured by the number of times it would be necessary to repeat the exposure. For example, so few burns have occurred at exposures equivalent to five times the safe exposure (i. e. $5 \times .5 = .25$), that the writer proposes to adopt 10 minutes at six inches as a standard therapeutic exposure. This is equivalent to 0.28 at one inch. If ten exposures were made, the total intensity would be 2.8, which would carry us well into the danger limit, as seen by reference to the table. It would not however insure a burn, for many such exposures have undoubtedly not caused trouble. Again, 100 such exposures—an intensity of 28.00, which is greater than that of nearly all the injuries reported, would probably be the limit for idiosyncrasy. The intervals at which exposures should be made we must gain from the following data.

Appearance of First symptoms.

The impression has prevailed that these lesions usually make their first appearance only after a number of days. The following is a table of the records as to this point.

In 9 instances signs or symptoms were noticed within 24 hours.							
" 6	"	"	"	"	"	"	2 days.
" 6	"	"	"	"	"	"	3 days.
" 2	"	"	"	"	"	"	4 days.
" 5	"	"	"	"	"	"	5 days.
" 3	"	"	"	"	"	"	6 days.
" 3	"	"	"	"	"	"	7 days.
" 4	"	"	"	"	"	"	8 days.
" 2	"	"	"	"	"	"	9 days.
" 9	"	"	"	"	"	"	10 days.
" 8	"	"	"	"	"	"	" 10-14 days inc.
" 8	"	"	"	"	"	"	" 15-21 days inc.
" 2	"	"	"	"	"	"	" 22-28 days inc.
" 3	"	(3, 4, 147)	"	"	"	"	after the 4th week.

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These figures indicate that at least in a good proportion of the cases the first symptoms are noticed

within the first few days after the exposure. Three are mentioned as being noticed *immediately* after the exposure. It seems possible that the reason that so many are first noticed in the 2nd and 3rd weeks is that it is at this time that the sensitiveness of the lesion becomes severe enough to attract the attention of the patient. In some cases, however, this late appearance is well substantiated, e. g., in the cases of Thompson, Orleman and Barthelemy. But five cases of my series 3, 4, 41, 126, 147 appeared later than 21 days. It is unfortunate that we have not more accurate reports of them.

The writer has been able to find no especial relationship between the early appearance of the lesion and the ultimate severity. It by no means follows that because a burn is severe, it appears early; or that because a burn appears late it will be of mild degree. Barthelemy's two extraordinary cases which appeared 5 months after exposure open up a new subject for investigation. How many lesions appear so late that they are mistaken for other things? Barthelemy also hints at other similar cases and promises a future report of them.

The question of intervals at which to repeat therapeutic doses of the X-Ray can be to a certain extent answered by these figures. If we wait three weeks after the initial dose we are reasonably sure of doing no damage. A shorter interval than this would be excusable if warranted by other conditions as the urgency of the case, the efficiency of the apparatus, the quality of the tube, etc.

The Portion of the Body Injured.

Nothing striking results from the consideration of our data on this subject. The reason that such a large proportion of the severe burns have occurred on the abdomen and groin is undoubtedly due to the fact that these are the thickest portions of the body and require the longest exposures.

Treatment.

The treatments which have been applied to these lesions have been many and for the most part unsatisfactory. Two main lines of treatment may be mentioned; (a) physiological rest and mild poulticing and (b) excision followed by skin grafting. The first should be used at least until the process has become stationary and has ceased spreading. The second only when pain is severe and rest has not produced improvement.

Precautions to Prevent Injury.

In exposures for skiagraphs the writer relies entirely on keeping the distance and time of exposure within proper limits. These limits are usually within those mentioned in table (a), though occasionally over them—never more than double the time. In therapeutic exposures the parts to be protected are covered by a lead plate. X-Ray workers who are constantly exposed should have the tube shielded in a suitable box with glass faces. It is perhaps well to use a grounded aluminum sheet between the patient and the tube.

CONCLUSIONS:

1. The frequency of X-Ray injuries has been much exaggerated by the medical press owing to the wide publicity given to many early cases.
2. The writer has been able to collect somewhat less than 200 cases, less than half of which were serious, and about one third of which occurred in X-Ray workers.
3. Judging from the experience with these injuries in Boston, it is the writer's opinion that a fair proportion of the severe burns are included in this series, while the dermatitis of skiagraphers is less well represented.
4. At a maximum estimate it is safe to say that not one patient in a thousand has been injured in the past five years by an X-Ray examination and in the past year not one in ten thousand.
5. More than two-thirds of these injuries occurred in the first two years of the use of the X-Ray. Only one mild case is reported as occurring in the current year, those cases in which the exposure has been made for therapeutic purposes being excluded.

6. The cause of X-Ray injuries is not definitely known. It is some form of energy closely allied to the photographically active X-Ray and radiates with it from the platinum terminal.

7. The primary injury is to the nerves controlling the nutrition of the skin.

8. There is no good evidence of injury to the deeper tissues without primary interference with skin.

9. The important factors which contribute to the production of X-Ray burns are: the intensity of the current used to stimulate the tube; the quality of the tube, the distance and time of exposure; the idiosyncrasy of the patient.

10. The static machine is somewhat less likely to produce injury than other forms of apparatus.

11. From the data of the reported cases we can say that no burn has been produced by an exposure equal to or less than the equivalent of 5 minutes at 10 inches.

12. It is impossible from the data to say how intense an exposure must be to produce a burn, for a comparison of the cases shows that an inconstant factor or factors exist.

13. These inconstant factors are more likely to lie in the complex human organism than in the less complicated construction of the tube.

14. General experience has shown that soft tubes produce a more intense effect on the tissues than hard.

15. While we cannot control these inconstant factors, therapeutic exposures will continue to be dangerous, and it is therefore important to record the exact conditions of the patient's local and constitutional idiosyncrasies, as well as those of the tube.

16. In cases of injury the time before the appearance of the first symptoms has varied from a few minutes to three weeks. Five cases have remained latent for over three weeks; two of these for five months.

17. It is impossible to predict the severity of the lesion from the time of its appearance after exposure.

18. The writer suggests 10 minutes at 6 inches from the platinum terminal, as a standard therapeutic exposure. This will make comparisons between the inconstant factors easier.

19. Unless signs of dermatitis appear within three weeks after the exposure, they are unlikely to appear at all. In one-third of the reported cases the appearance occurred within the first four days; in one-half the cases before the ninth day.

20. In the ordinary X-Ray examination with fluoroscope or skiagraph, the operator takes the entire responsibility of injury; in exposures for therapeutic purposes the patient shares the responsibility.

BIBLIOGRAPHY.

CASE 1.—Reported by Apostoli. *Comptes Rendues*, XII, Cong. Internat. de Méd., Aug. '97, Vol. 4, Part 2, Sect. 8, 493-495. Exposure made in Dublin. 1st exposure 15 cm. for 40 min. 2nd 9 cm. for 90 min. May 22 and 28, '96. Developed in 2 days on abdomen and lasted 15 mos. Severe. Nausea without vomiting after each exposure.

CASE 2.—Balzer and Moussand. *Annales de Derm. and Syph.* 3, S, 10, '99.41. Skiagrapher's Dermatitis. Hands, neck and face.

CASE 3.—Barthelemy. *Annales de Derm.* Feb. 1901. Many exposures. Developed in 5 mos. after exposure. Superficial. Patient had syphilis.

CASE 4.—Barthelemy. *Annales de Derm.* Feb., 1901. Patient of Fournier. Burn was severe; developed 5 months after last exposure. B. is now writing a monograph with 10 unpublished cases.

CASE 5.—Bannister, Capt. W. B., *Med. Rec.*, Jan. 23, '97. 3 exposures one and a half hour each, 8 with a total of 12 hours a month later. Abdomen. Severe ulceration. Wore a light cotton undershirt during exposure.

CASE 6.—Barthelemy, Oudin and Darier, *Comptes Rendues* XII, Cong. Internat. de Méd., Aug., '97, Vol. 4, Part 2, Sect. 8, p. 459. Skiagrapher's dermatitis. Quoted from *Quinzaine Méd.*, April 1, '97.

CASES 7, 8, 9, 10 and 11.—Same authors. Similar cases.

CASE 12.—Behrend, Dr. Gustave, *Berl. klin. Woch.*, June 6th, '98. Skiagrapher's dermatitis.

CASE 13.—Dr. Below. *Münch. med. Woch.*, March 1st, '98. Daily exposures. Blisters and exfoliation of face. Patient was impatient for removal of hair on face, and approached tube so near that sparks jumped across.

CASE 14.—Bernard. *Lyon. Méd.*, '00, XCIII, 442. One exposure 35 minutes. First symptoms appeared in 9 days on shoulder. Severe. Ulcer. There was an aluminum screen used, but probably of insufficient size.

CASE 15.—Bloom, J. M., *Louisville Med. and Surg. Jour.*, Vol. VII, '00, p. 289. One exposure, 30 minutes. First symptoms in 5 days, lasting 10 mos. Abdomen. Severe ulceration. Recovered after skin grafting.

CASE 16.—Borden, Maj. W. C., "Use of the Röntgen Ray in the war with Spain." Coil. 10 inches from platinum reflector. 3 exposures on successive days, 20 minutes each. First symptoms 6 days after last exposure. Chest. Not healed 11 mos. later. Ulceration.

CASE 17.—Borden, Maj. W. C., "Use of the Röntgen Ray in the War with Spain." Static machine. 3 exposures every other day. 25 minutes each. First symptoms 5 days after last exposure. Lasted 10 days. Abdomen. Erythema and hyperesthesia.

CASE 18.—Borden, Maj. W. C. Personal communication

to E. A. C., Static Machine. 3 exposures every other day, 30 minutes each, at about 8 inches. First symptoms appeared three days after last exposure. Left hip. Lasted 16 days. Erythema and hyperesthesia. Slight exfoliation.

CASE 19.—Bronson, J., *Cut. and G. U. Dis.*, '97, p. 478. Tesla Coil. Patient said 6 inches, operator said 15 inches from platinum terminal. 5 exposures, 1 for 80 min. and 4 for 1 hour. Hip. Severe ulceration. Taken through a chemise.

CASE 20.—Buguet, Abel, *Techniques Méd. Rayons*, 3 cm., 45 min. Temple. Severe ulceration and depilation.

CASE 21.—Buri. *Monat. f. prak. Derm.*, XXVIII, No. 9, May, '99. Strong coil. Many exposures. Dermatitis of the left hand. Palpitation and dyspnea. Gives a photo., showing changes in nails.

CASE 22.—Burrell, H. L. As yet unreported. Patient was George D. Exposure in New York. 16 inches in first two, 20 in. in third for 25 minutes each. Epigastrium. Ulceration lasting for seven mos. Data from statements of patient.

CASE 23.—Butler, Thomas L. *Jour. of Electro Therapeutics*, Oct., '00. Static Machine. Skiagrapher's dermatitis.

CASE 24.—Same author. Same ref. Static machine. Skiagrapher's dermatitis.

CASE 25.—Same author, same ref. Tesla coil. Skiagrapher's dermatitis of face.

CASE 26.—Same author, same ref. Tesla coil. First symptoms appeared 10 days after exposure. Right iliac region. Severe ulceration lasting a year and a half, complicated by ulcerating sarcoma.

CASE 27.—Same author, same ref. First symptoms 10 days after exposure. Iliac region. Burn of second degree, lasting many months. Formation of leathery tissue without ulceration. Skin grafted.

CASE 28.—Same author, same ref. Tesla coil. Small burn of second degree in groin.

CASE 29.—Same author, same ref. Tesla coil. Burn of first degree on face.

CASE 30.—Same author, same ref. Tesla coil. Fore-arm and back of hand. Burn in the first degree.

CASE 31.—Same author, same ref. Tesla coil. Burn of first degree on anterior chest.

CASE 32.—Caffrey and Wilson. *Elect. World*. Jan. 9th, '97. 2 Exposures for 3 hours each. Fingers. Dermatitis and ulceration. Also some remarkable cases of deep effects. Healed in 3 mos. under boracic acid.

CASE 33.—Cassidy, Dr. P., *Case of Dr. Weldon*. *Med. Rec.*, LVII, 180, '00. Static machine. 1 exposure of 45 min. 5 in. from tube. First symptoms in one week. Left groin. Lasted a year and a half. Deep ulceration. Leath-

ery necrosis. Dissection of groin was done, removing necrotic tissue, later Reverdin grafts.

CASE 34.—Clark, C. F., *Trans. Ohio Med. Soc.*, '97, p. 139. Case of alopecia without inflammation, mentioned in discussion of Dr. Scott's paper.

CASE 35.—Codman, E. A. Present article. Allard, Henry. Case was not seen by writer. Deep ulceration of abdomen above umbilicus.

CASE 36.—Codman, E. A. Present article. Case of W. J. D. Very severe skiagrapher's dermatitis. Repeated exposures for months. Hands and somewhat on face and other parts. Permanent loss of several nails. Ulceration involving extensor tendons, necessitating skin grafting. The process has existed with exacerbations from continued exposures for five years.

CASE 37.—Conrad. *Codex Medicus*, Aug., '96. Skiagrapher's dermatitis.

CASE 38.—Corlett, W. T., *Cleveland Med. Gaz.*, '96, 97, p. 696. Distance 8 in. from platinum reflector for 45 min. Thigh. Ulceration. After 6 mos. excision and skin-grafting was done.

CASE 39.—Crocker, H. Radcliffe, B. M. J. Jan. 2nd, '97. Coil. 1 hour at 5 in. from platinum. First symptoms in 24 hours. Epigastrium. Severe ulceration. Lower border sharply marked, where trousers were turned down.

CASE 40.—Daniel, Prof. J. *N. Y. Med. Rec.*, April 25th, '96. Coil. 1 hour at a half inch from tube. Side of head. Alopecia. No inflammation.

CASE 41.—Dale, J. Y. *Med. News*, July 24, '97.

CASE 42.—Delorme. *Bull. et Mem. Soc. de Chir.* April 7, '97, p. 296. Alopecia.

CASE 43.—Destot. *Fortschritte Rönt.-Strahl.*, Vol. 3, '00. H. 5. 30 cm. from platinum for 20 min. Knee.

CASE 44.—Destot. *Acad. Sci.*, May 17, '97, 10 cm. from platinum for 30 min. Thorax.

CASE 45.—Deutschländer. See Kienböck. *Wien. klin. Woch.*, '00, p. 1155. 15 cm. from platinum. 52 min., in 5 exposures. Inguinal region. Ulceration.

CASE 46.—Dowie, W. *Ed. Med. Jour.*, Jan., '97. Coils. Several exposures. Burn appeared 10 days after last exposure. Neck and scalp. Ulceration.

CASE 47.—Drury, H. C. *B. M. J.*, Nov. 2, '96, p. 1877. Coil. Several exposures at an inch or two from tube. Exposures two hours and a half. Dermatitis began 2nd day after 2nd exposure. There was nausea after each exposure. Ulceration for 4 mos. Clothing and celluloid between patient and tube.

CASE 48.—Elliot. *Jour. Cut. and G. U. Dis.* '97, p. 478. Chest. Referred to in discussion of Dr. Bronson's paper. This and following cases were in boys who were used to demonstrate the fluoroscope.

CASE 49.—Same author, same ref. Chest.

CASE 50.—Feilchenfeld. Deutsch. med. Woch., July 23, '96. Face. Case similar to that of Marceuse. No details.

CASE 51.—Ferrier, Charles. Cong. Fran. de Chir. Paris, '99, XIII, p. 611. Coil. Several exposures. Skiagrapher's dermatitis.

CASE 52.—Same author, same ref. Coil. 3 exposures for 45 min. at 11 cm. Symptoms appeared first in two days. Groin. Lasted 10 mos. Ulceration.

CASE 53.—Forster, A. Deutsch. med. Woch., Feb. 11, '97. 2 exposures, 25 min. at 10 cm. Symptoms appeared in 5 days. Dermatitis, alopecia.

CASE 54.—Same author, same ref. 5 exposures, amounting to 2 hours at 8 or 10 cm. Head. Dermatitis, alopecia.

CASE 55.—Freund, Leopold. Wien. med. Woch., Mar. 6, '97. Coil. 10 exposures, 2 hours each. For removal of superfluous hair. Child was anemic and tuberculous. Mild dermatitis on back and neck.

CASE 56.—Frie. Elect. Rev., Aug. 19, '96. Daily exposures. Skiagrapher's dermatitis.

CASE 57.—Fuchs, Paul. Deutsch. med. Woch., No. 35, Aug. 27, '96. Coil. 16 cm. for one hour. Hand looked as if frozen during exposure. Vesicles appeared 15 min. later.

CASE 58.—Gage, W. B. Med. Rec., Aug. 29, '96. Abdomen of a child. Ulceration. Mentions indefinitely other cases of alopecia.

CASE 59.—Gassmann. Fortschritte Rönt.-Strahl., 1900, II, p. 121. 4 exposures of 20 min. each at 5 cm. Thigh. Ulceration. Was excised and skin grafted.

CASE 60.—Same author, same ref. P. 199. 3 times a week, 10 or 20 min. each. Shoulder. This was also excised and grafted. Cases 59 and 60 are quoted from Kienböck.

CASE 61.—Gilchrist, T. C. Johns Hopkins Bulletin, Feb. '97. Skiagrapher's dermatitis. Reported as a case of osteoplastic periostitis.

CASE 62.—Gray, W. M. Personal communication to E. A. C. Coil. 2 exposures of 30 min. each at 6 in. First symptoms appeared in two weeks and lasted three mos. Groin. Ulceration and gray slough. Taken through clothing.

CASE 63.—Greene. See Dr. N. Stone Scott's article. Coil. 3 exposures 1 hour each at 8 in. Head. Burn of 2nd degree lasting 3 mos.

CASE 64.—Hawks, H. D. Elect. Rev., Vol. 29, No. 7. Powerful coil. Skiagrapher's dermatitis.

CASE 65.—Havas, A. Ungar. med. Presse, '99, 4, p. 38. Dermatitis of face following attempt to remove hair. Severe.

CASE 66.—Hoffa. Fortschritte Rönt.-Strahl., Vol. 2, p. 110. 1 exposure of 35 min. at 30 cm. Groin. Ulceration.

Quoted by Kienböck and probably case of E. E. mentioned by E. A. C.

CASE 67.—Ivanischevitch. *Gaz. Hebdomadaire de Méd. and Chir.* Paris, '99, p. 517. 3 exposures for 55 min. 1st symptoms appeared in 15 days. Hand. Blebs and exfoliation.

CASE 68.—Jackson, G. S. *Jour. Cut. and G. U.*, '00, XVIII, p. 177. Dermatitis of face.

CASE 69.—Jones, F. S. *Elect. Rev.*, '96. Dermatitis behind ear and on face. Occurred in the physical laboratory in the University of Minnesota.

CASE 70.—Jones, H. S. *Clinical Jour.*, Mar. 30, '98. Static machine. Skiagrapher's dermatitis.

CASE 71.—Kaposi. *Wien. klin. Woch.*, '99, p. 1113. Repeated exposures at 10 cm. Severe. Hand. Mentions a number of other cases indefinitely which are probably included elsewhere.

CASE 72.—Kessabian, Mihran K. *Am. X-Ray Jour.*, Oct., '00. 3 exposures at 15 in., 30 min. in all. 1st symptoms in 2 weeks. Side of face. Alopecia.

CASE 73.—Same author, same ref. Skiagrapher's dermatitis.

CASE 74.—Same author, same ref. Skiagrapher's dermatitis.

CASE 75.—Kienböck. *Wien. klin. Woch.*, Dec. 13, '00. 78 min. at 20 cm. Abdomen. Ulceration. Other cases are given which have resulted from therapeutic treatment.

CASE 76.—Kibbe, A. B. *N. Y. Med. Jour.*, Jan. 16, '97. Coil. Several exposures at 4 inches. First symptoms appeared in two days on face and elbow. Mild. Elbow covered with clothing.

CASE 77.—King, E. E. *Canad. Pract.*, Nov., '96. Coil. Skiagrapher's dermatitis.

CASE 78.—Kolle, F. S. *Brooklyn Med. Jour.*, Dec., '96. Coil. First symptoms appeared in nineteen days. Alopecia. No inflammation. Lasted four months.

CASE 79.—Lassar, Prof. *Berlin Med. Soc., Abs. P. M. J.*, April 16, '98. It is probable that this is the same case as that of Plonski from the same clinic. Abdomen. Severe ulceration lasting over a year. Woman was pregnant. She had had a previous exposure without ill effects.

CASE 80.—Launois. *Soc. Méd. des Hôp.*, Jan. 15, '97. Referred to by Barthelemy as reporting one grave and several mild cases.

CASE 81.—Lederman. *Annales de Derm. & Syph.* Allusion to scars on back, resulting from many exposures.

CASE 82.—Lee, E. H. *Jour. Am. Med. Assoc.*, Jan. 16, '97. Many exposures of head. Dermatitis and ulceration. Eyes closed during exposure, but a conjunctivitis developed.

CASE 83.—Leppin, O. *Deut. med. Woch.*, July 9, '96, No. 28. Skiagrapher's dermatitis.

CASE 84.—Leonard, C. L. N. Y. M. J., July 2, '98. "A burn of considerable extent, but not severe in character," on abdomen. Two other cases referred to in therapeutic use.

CASE 85.—Lustgarten, S. Jour. Cut. and G. U. Dis., 1897, p. 525. Eleven inches from platinum, fourteen exposures for fifteen to thirty minutes each. Abdomen severe ulceration. For therapeutic effect.

CASE 86.—Same author, same ref. Severe ulceration of hand which was purposely exposed to remove nails.

CASE 87.—Lyon, Howard. Albany Med. Ann., 240, '00, 21. Coil. Ten minutes at three to four inches. First symptoms developed two weeks later. Knee. Lasted three years. Question whether this is Dr. Tuttle's case.

CASE 88.—Mansell, Harry. Occurred in Hastings, Eng., taken by Mr. Bloomfield. Notice in Med. Press and Circular, Nov. 21, 1900, page 548, and in Sc. Am., Jan. 26, 1901. Patient was an elderly woman. Burn on left side of abdomen. Slough 7x3 inches. She was exposed the first 80 minutes in two sittings, the second time for 45 minutes in one sitting. Distance not given. Death six months later. Coroner's verdict, "that death was due to shock and exhaustion following the accident and the effects of the Röntgen rays on a weakened system." Note:—The injury was a fracture of the neck of the femur.

CASE 89.—MacIntyre, J. Nature, Nov. 19, 1896. Skiagrapher's dermatitis.

CASE 90.—Marceuse. Deut. med. Woch., No. 30, July 23, 1896. Coil. Skiagrapher's dermatitis. Face.

CASE 91.—Meis, Jos. Deut. med. Woch., '97, June. Many exposures dermatitis of face, done by a homeopath for facial paralysis. Another case by same man on abdomen alluded to.

CASE 92.—Montgomery. Occid. Med. Times, June 1901. Ann. of Surgery, Dec., 1901. Static machine. Ulceration on abdomen. Excision and skin grafting.

CASE 93.—Merrill, Walter H. Cases of severe burn alluded to as reported by Dr. Vaughn at a medical society in Washington. Dr. Merrill has also performed several successful experiments on his own arm.

CASE 94.—Mockert, Mme. Given Macquaire. B. M. J. April 2, '99. Ed. Presse Médicale, April 1, 1899, page 125. Severe ulceration. Suit for damages.

CASE 95.—Newcomb, G. S. Mod. Med. Sci., Nov., 1896. Skiagraphers dermatitis.

CASE 96.—Noir, Julian. Le Prog. Méd., July 2, 1898, 17 minutes at 10 cm. Dermatitis of hand appeared in 8 days. Note:—While dermatitis existed, an accidental scratch on it healed normally.

CASE 97.—Orleman, Daisey M. N. Y. Med. Rec., July 1, '99, page 8. Coil. Three exposures of 7 minutes each at

10 inches. One exposure in January, another in March, another in May. First symptoms appeared 21 days after last exposure. Thigh. Severe ulceration. Excision and skin grafting unsuccessful at first.

CASE 98.—Oudin and Carnaud. See Barthelemy. Several exposures. Dermatitis of scalp and alopecia. Exposures made for the cure of deafness.

CASE 99.—Same authors, daughter of the above patient, similar lesions.

CASE 100.—Oudin. Bull. de la Soc. d' Elec.-Ther., March, 1901. Perhaps same case as No. 27. Symptoms did not appear until 5 or 6 months after exposure.

CASE 101.—Parker, W. E. New Orleans Med. & Surg. Jour., Sept., '96, p. 158. Burn occurred at Chicago. Many exposures. Dermatitis of left cheek.

CASE 102.—Plonski. Dermat. Zeitsch., '98, p. 36. (Statement of patient). One exposure for 30 minutes at 50 cm. Burn appeared next day on abdomen. Lasted eleven months. Severe ulceration. Examination undertaken to determine position of fetus. Dead child born at term 3 months after. She was in the sixth month when the X-ray was used.

CASE 103.—Ramsey, Prof. Wm. Spoken of by Downie. Skiagrapher's dermatitis.

CASE 104.—Rendu and Du Castel. Soc. Méd. des Hôp., Jan. 15, '97. Coil. Several exposures. Dermatitis and ulceration of chest. Authors claim improvement in pneumonia.

CASE 105.—Reid, E. W. Mon. Med. Jour., April, '97. Also Scot. Med. & Surg. Jour., Feb. '97. Coil. Several exposures. Dermatitis of abdomen and chest. Waistcoat lined with scarlet flannel worn during exposure.

CASE 106.—Richardson, M. H. Case of Dr. Stickney. Med. News, Dec. 26, '96. Three exposures amounting to 85 minutes at 18 inches. Burn appeared in two days on abdomen. Ulceration lasted four months.

CASE 107.—Rockwell, A. D. Med. Rec., April 24, '97. Static machine. Skiagrapher's dermatitis.

CASE 108.—Robinson, A. R. Jour. of Cut. & G. U. Dis., '97, page 526. First symptoms appeared in five days. Chest. Severe ulceration.

CASE 109.—Schmidt. Case of Mallet vs. Schmidt. Elec. Review, Vol. XXX, No. 8, Feb. 24, '97. Negro. Bad burn of chest.

CASE 110.—Schmidt. Wien. klin. Woch., '00, page 1155. Severe burn of abdomen. See Kienböck.

CASE 111.—Schmidt, Otto L. Case of Balling F. B. vs. Schmidt. Am. X-Ray Jour., May, '99. Severe burn of dorsum of ankle and foot. Amputation finally became necessary from pain and ulceration. Two reamputations.

CASE 112.—Scott, J. W. Am. X-Ray Jour., Aug., '00.

Fifteen minutes at at least 8 inches in two exposures. First symptoms appeared three hours after exposure. Neck; erythema. Rubber sheet between patient and tube. Patient was nervous. Fainted at second exposure.

CASE 113.—Same author, same ref. Two for ten minutes each at 10 inches. First symptoms one week after second exposure. Dermatitis of shoulder, hip and back of hand. Rubber sheet. Hip which was under anode not burned.

CASE 114.—Scott, N. Stone. American X-Ray Jour., Aug., '97. Original article in Trans. Ohio Med. Soc., '97, page 139. Case No. 1 of Dr. Scott's series. Coil. Severe burn of left thigh.

CASE 115.—Same author, same ref. No. 45 of series, superficial burn of thigh.

CASE 116.—Same author. No. 9. Skiagrapher's dermatitis.

CASE 117.—Same author. No. 21. Coil. Two exposures of 30 minutes each at eight inches, first symptoms in ten days. Arm and hand. Symptoms of periostitis. Inflam. said to have delayed op. for dislocation of ulna. Dermatitis?

CASE 118.—Same author. No. 65. Coil. Inexact data. Mild case. Chest.

CASE 119.—Same author. No. 66. Inexact data. Mild case. Back.

CASE 120.—Same author. No. 67. Inexact data. Mild case. Back.

CASE 121.—Same author. No. 13. Coil. Two exposures 30 minutes each, 3 inches from platinum. Breast. Like burn of second degree.

CASE 122.—Same author. No. 14. Coil. One exposure for five minutes. Slight burn of wrist lasting two weeks.

CASE 123.—Same author. No. 12. Coil. Skiagrapher's dermatitis.

CASE 124.—Same author. No. 17. Tesla coil. One exposure for 30 minutes at six inches. First symptoms appeared in two hours. Superficial burn of knee.

CASE 125.—Same author. No. 23. Coil. Three exposures, 1½ hours each at six inches. Abdomen; mild; cloth over skin.

CASE 126.—Same author. No. 24. Three exposures for 1½ hours each at six inches. Symptoms appeared in four weeks; left hip, dermatitis and ulceration. Used vaseline at each exposure freely.

CASE 127.—Same author. No. 40. Coil. Three exposures of 5 minutes each at one or two inches. First symptoms in ten days. Chest and hand. Mild.

CASE 128.—Same author. No. 20. Coil. Skiagrapher's dermatitis.

CASE 129.—Same author. No. 38. Skiagrapher's der-

matitis. See Nature, Oct. 29, 1896, probably same case as reported by Barthelemy.

CASE 130.—Same author. No. 18. One exposure for 20 minutes at one inch. Thigh.

CASE 131.—Same author. No. 19. One exposure for 30 minutes. Thigh.

CASE 132.—Same author. No. 41. Coil. One exposure for five hours at from 2 to 8 inches. Head. Ulceration extended to bone.

CASE 133.—Same author. No. 42. Severe burn of abdomen.

CASE 134.—Same author. No. 43. Superficial burn of chest.

CASE 135.—Same author. No. 44. Superficial burn of chest.

CASE 136.—Schrwald. Deut. med. Woch., Oct., '96. Coil. One exposure for 45 minutes at 14 cm. from skin. First symptom appeared in two weeks. Abdomen: dermatitis and ulceration, lasting 9 or 10 weeks.

CASE 137.—Sewall. Lancet, '96, Vol. II, page 1049. Alopecia and dermatitis of neck.

CASE 138.—Scherwell. Jour. of Cut. & G. U. Dis., '99, Vol. XVII, page 40. Superficial burn of shoulder, knee and temple. No details.

CASE 139.—Skinner, G. C. Dr. Scott's article. Am. X-ray Jour., Aug., '97. Three exposures, 20 minutes each: 4 inches. Ulceration and implication of tendon sheaths of wrist. Tesla Coil.

CASE 140.—Same author, same ref. Tesla coil. Abdomen: severe.

CASE 141.—Sorel, M. A. Bull. de la Soc. Fran. de Photo., 2. s., Vol. XIII. Coil. One exposure of 20 minutes at 1 cm. from tube. First symptoms appeared in 6 days. Epigastrium. Severe ulceration. Thin sheet of celluloid between tube and patient.

CASE 142.—Same author, same ref. Coil. Mild dermatitis. Groin.

CASE 143.—Sterne, Max J. Am. Med. & Surg. Bull., Nov. 21, '96. Three exposures of 40 or 50 minutes each at 3 inches. Chest, severe.

CASE 144.—Stephens, L. G. B. M. J., Apr. 18, '97. In report on R. R. by Rowland. Mild case. Skiagrapher's dermatitis.

CASE 145.—Stein, W. M. Elect. Review, '96. Skiagrapher's dermatitis.

CASE 146.—Same author, same ref. Mild case on back. Patient had on thin clothing.

CASE 147.—Stinson, J. Coplin. Med. News, Oct. 7, '99, page 463. Groin. Severe case. Leathery slough. First

symptoms did not appear for 6 weeks. Final scar was soft.

CASE 148.—Testaz. *La Radiographie*, June or July, 1901. Severe case.

CASE 149.—Thompson, Elihu. *Boston Med. and Surg. Jour.*, Dec. 10, '96. Small rubber plate static machine. One exposure for 30 minutes at $1\frac{1}{4}$ inches. First symptoms in 9 days. Little finger. Ulceration. Experimental case.

CASES 150, 151 and 152.—Same author, same ref. Three cases of skiagrapher's dermatitis.

CASE 153.—Same author, same ref. One exposure for 12 minutes at $\frac{5}{8}$ of an inch from glass. First symptoms appeared in 11 days. Finger. Mild. Experimental case.

CASE 154.—Tuttle. *N. Y. Med. Rec.*, March 5, '98. Coil. Details not given. First symptoms in three weeks, back of knee. Skin grafting was done which later broke down. Amputation. Alluded to two other cases.

CASE 155.—Weldon, J. Case of Mr. Long, alluded to in case of Weldon vs. Otis Clapp & Son. Static machine. Case had previously been exposed to coil. Half hour at 8 inches. Symptoms of burn of second degree. Patient died soon after. Dr. W. signed death certificate as apoplexy and fatty degeneration of heart. Did not believe burn was cause of death.

CASE 156.—White, J. C. *Boston M. & S. J.*, Dec., '96. Two exposures amounting to 75 minutes at 6 inches. First symptoms appeared the day after the second exposure. Breast. Deep ulceration.

CASE 157.—Wiley, A. B. M. J., '99. Reference lost. Superficial ulcer lasting three weeks.

CASE 158.—Ryan. *Brit. Jour. of Derm.*, Aug., '97. Shoulder. Mild.

CASE 159.—*Med. Press & Circ.*, Oct. 10, 1900, page 378. Alludes to a man at St. Paul, U. S. A., who died after an X-ray exposure and a street car accident. Death certificate says that death was due to X-ray burn.

CASES 160, 161 and 162.—Salvador. *Thèse de Lyon*, '99, mentions two cases of skiagrapher's dermatitis. One reported by Nobele and another by himself. He also reports some experimental observations made on himself. Also a number of accidents in therapeutic cases. Also one case of severe burn.

CASES 163 to 171 inc.—Nine additional cases of mild skiagrapher's dermatitis of hands in friends and acquaintances of the writer. One was caused by the static machine, the rest by coils or both.

NOTE:—1. Dr. Francis Carleton of Providence, in the

Weldon trial, alluded indefinitely to cases which he had seen caused by both static machines and coils.

2. Dr. Valentine Zárubin, in Monatshefte für prak. Derm., XXVIII, No. 10, May 15, gives a general discussion of cases without definite reference.

3. While this article has been in print, Dr. Beck has published a few additional cases in the N. Y. Med. Rec., Jan. 18, '00, p. 83.

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